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國立清華大學 109 學年度碩士班考試入學試題

系所班組別：生命科學院
丁組(醫學生物科技學程)

科目代碼：0702

考試科目：生物學

—作答注意事項—

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2. 作答中如有發現試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
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5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清（含未依範例畫記）致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
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國立清華大學 109 學年度碩士班考試入學試題

系所班組別：生命科學院甲組、丁組

考試科目（代碼）：生物學(0402、0702)

 *請在【答案卡】作答

單選題 (每題二分，共一百分，答錯不倒扣。)

1. One primary advantage of light microscopy over electron microscopy is that _____.
   A) light microscopy provides for higher magnification than electron microscopy
   B) light microscopy provides for higher resolution than electron microscopy
   C) light microscopy allows the visualization of dynamic processes in living cells
   D) light microscopy provides higher contrast than electron microscopy

2. Which of the following is the most common pathway taken by a newly synthesized protein that will be secreted by a cell?
   A) rough ER → Golgi → transport vesicle → nucleus
   B) Golgi → rough ER → lysosome → transport vesicle → plasma membrane
   C) rough ER → Golgi → transport vesicle → plasma membrane
   D) rough ER → lysosome → transport vesicle → plasma membrane

3. Cell membranes have distinct inside and outside faces. Which of the following statements is the most likely explanation for the membrane's asymmetrical nature?
   A) Since the cell membrane forms a border between one cell and another in tightly packed tissues such as epithelium, the membrane must be asymmetrical.
   B) Since cell membranes communicate signals from one organism to another, the cell membranes must be asymmetrical.
   C) The two sides of a cell membrane face different environments and carry out different functions.
   D) Proteins only function on the cytoplasmic side of the cell membrane, which results in the membrane's asymmetrical nature.

4. Celery stalks that are immersed in fresh water for several hours become stiff. Similar stalks left in a 0.15 *M* salt solution become limp. From this we can deduce that the fresh water _____.
   A) and the salt solution are both hypertonic to the cells of the celery stalks
   B) is hypotonic and the salt solution is hypertonic to the cells of the celery stalks
   C) is hypertonic and the salt solution is hypotonic to the cells of the celery stalks
   D) is isotonic and the salt solution is hypertonic to the cells of the celery stalks

5. Which of the following types of reactions would decrease the entropy within a cell?
   A) anabolic reactions
   B) hydrolysis
   C) digestion
   D) catabolic reactions

6. Which of the following conditions may be overcome by increasing the substrate concentration in an enzymatic reaction with a fixed amount of enzyme?
   A) the need for a coenzyme
   B) allosteric inhibition
   C) noncompetitive inhibition
   D) competitive inhibition

7. Which kind of metabolic poison would most directly interfere with glycolysis?
   A) an agent that reacts with oxygen and depletes its concentration in the cell
   B) an agent that binds to pyruvate and inactivates it
   C) an agent that closely mimics the structure of glucose but is not metabolized
   D) an agent that reacts with NADH and oxidizes it to NAD^+

8. Energy released by the electron transport chain is used to pump H^+ ions into which location in eukaryotic cells?
   A) cytoplasm adjacent to the mitochondrial outer membrane
   B) mitochondrial inner membrane
   C) mitochondrial intermembrane space
   D) mitochondrial matrix

9. A spaceship is designed to support animal life for a multiyear voyage to the outer planets of the solar system. Plants will be grown to provide oxygen and to recycle carbon dioxide. Since the spaceship will be too far from the sun for photosynthesis, an artificial light source will be needed. Suppose a plant has a unique photosynthetic pigment and the leaves of this plant appear to be reddish yellow. What wavelengths of visible light are absorbed by this pigment?
   A) red and yellow
   B) blue and violet
   C) green and yellow
   D) green and red

10. $P680^+$ is said to be the strongest biological oxidizing agent. Given its function, why is this necessary?
    A) It is the receptor for the most excited electron in either photosystem of photosynthesis.
    B) It is the molecule that transfers electrons to plastoquinone (Pq) of the electron transfer system.
    C) It transfers its electrons to reduce $NADP^+$ to NADPH.
    D) It obtains electrons from the oxygen atom in a water molecule, so it must have a stronger attraction for electrons than oxygen has.

11. In the formation of biofilms, such as those forming on unbrushed teeth, cell signaling serves which function?
    A) formation of mating complexes
    B) aggregation of bacteria that can cause cavities
    C) secretion of substances that inhibit foreign bacteria
    D) digestion of unwanted parasite populations

12. Not all intercellular signals require transduction. Which one of the following signals would be processed without transduction?
    A) a lipid-soluble signal
    B) a signal that is weakly bound to a nucleotide
    C) a signal that binds to a receptor in the cell membrane
    D) a signal that binds to the extracellular matrix

13. FtsZ is a bacterial cytoskeletal protein that forms a contractile ring involved in binary fission. Its function is analogous to _____.
    A) the cleavage furrow of eukaryotic animal cells
    B) the cell plate of eukaryotic plant cells
    C) the mitotic spindle of eukaryotic cells
    D) the microtubule-organizing center of eukaryotic cells

14. Several organisms, primarily protists, have what are called intermediate mitotic organization. What is the most probable hypothesis about these intermediate forms of cell division?
    A) They represent a form of cell reproduction that must have evolved completely separately from those of other organisms.
    B) They rely on totally different proteins for the processes they undergo.
    C) They may be more closely related to plant forms that also have unusual mitosis.
    D) They show some but not all of the evolutionary steps toward complete mitosis.

15. A particular organism has 46 chromosomes in its karyotype. Which of the following statements is correct regarding this organism?
A) It must be human.
B) It must be an animal.
C) It reproduces sexually.
D) It produces gametes with 23 chromosomes.

16. Somatic cells of roundworms have four individual chromosomes per cell. How many chromosomes would you expect to find in an ovum from a roundworm?
A) four
B) two
C) eight
D) a diploid number

17. Albinism is a recessive trait. A man and woman both show normal pigmentation, but both have one parent who has albinism (without melanin pigmentation). What is the probability that their first child will have albinism?
A) 0
B) 1/2
C) 1/4
D) 1

18. Feather color in budgies is determined by two different genes, Y for pigment on the outside of the feather, and B for pigment on the inside of the feather. YYBB, YyBB, or YYBb is green; yyBB or yyBb is blue; YYbb or Yybb is yellow; and yybb is white. Two blue budgies were crossed. Over the years, they produced 22 offspring, five of which were white. What are the most likely genotypes for the two blue budgies?
A) yyBB and yyBB
B) yyBB and yyBb
C) yyBb and yyBb
D) yyBb and yybb

19. Which of the following individuals will inherit an X-linked allele from a man who carries it?
A) all of his daughters
B) half of his daughters
C) all of his sons
D) all of his children

20. A couple has a child with Down syndrome. The mother is 39 years old at the time of delivery. Which of the following is the most probable cause of the child's condition?
    A) The woman inherited this tendency from her parents.
    B) The mother had a chromosomal duplication.
    C) One member of the couple underwent nondisjunction in somatic cell production.
    D) One of the gametes in the mother most likely underwent nondisjunction during meiosis.

21. In an analysis of the nucleotide composition of a molecule of DNA, which of the following combinations of base pairs will be found?
    A) A = C
    B) A = G and C = T
    C) A + C = G + T
    D) G + C = T + A

22. What are telomeres?
    A) the structures that hold two sister chromatids together
    B) enzymes that elongate the DNA strand during replication
    C) the sites of origin of DNA replication
    D) the ends of linear chromosomes

23. Transcription in eukaryotes requires which of the following molecules in addition to RNA polymerase?
    A) anticodons
    B) ribosomes and tRNA
    C) several transcription factors
    D) aminoacyl-tRNA synthetase

24. What is the function of the release factor during translation in eukaryotes?
    A) It binds to the stop codon in the A site in place of a tRNA.
    B) It releases the amino acid from its tRNA to allow the amino acid to form a peptide bond.
    C) It supplies a source of energy for termination of translation.
    D) It releases the ribosome from the ER to allow polypeptides into the cytosol.

25. How does the transcription of structural genes in an inducible operon occur?
    A) It occurs continuously in the cell.
    B) It starts when the pathway's substrate is present.
    C) It starts when the pathway's product is present.
    D) It stops when the pathway's product is present.

26. Which of the following methods is utilized by eukaryotes to control their gene expression that is different from the type of control found in bacteria?
A) control of chromatin remodeling
B) control of RNA splicing
C) transcriptional control
D) control of both RNA splicing and chromatin remodeling

27. Which of the following characteristics correctly describes retroviruses?
A) They are made up of only a single protein.
B) They can only reproduce by infecting bacteria.
C) They have a single-stranded DNA that acts as a template for DNA synthesis.
D) They have a single-stranded RNA that acts as a template for DNA synthesis.

28. What are prions?
A) mobile segments of DNA
B) tiny circular molecules of RNA that can infect plants
C) viral DNA that attaches itself to the host genome and causes disease
D) misfolded versions of normal proteins that can cause disease

29. Which of the following correctly lists the processes in order for one cycle of polymerase chain reaction (PCR)?
A) denature DNA; add fresh enzyme; anneal primers; add dNTPs; extend primers
B) anneal primers; denature DNA; extend primers
C) extend primers; anneal primers; denature DNA
D) denature DNA; anneal primers; extend primers

30. Which of the following statements describes one of the technical reasons why gene therapy is problematic in humans?
A) Most cells with an engineered gene do not produce gene product.
B) Cells with transferred genes are unlikely to replicate.
C) Transferred genes may not have appropriately controlled activity.
D) mRNA from transferred genes cannot be translated.

31. The apoplast in plant tissues consists of _____.
A) cell walls, extracellular spaces, and plasmodesmata
B) cell walls, extracellular spaces, and vessel elements
C) vessel elements, plasmodesmata, and extracellular spaces
D) cell walls, plasma membrane, and cytosol

32. Which of the following primarily enters a plant somewhere other than through the roots?
    A) carbon dioxide
    B) nitrogen
    C) potassium
    D) water

33. Soil pH is an important factor that influences _____.
    A) cation exchange
    B) the chemical form of minerals
    C) availability of minerals
    D) cation exchange and the chemical form of minerals

34. Why is nitrogen fixation an essential process?
    A) Nitrogen fixation can only be done by certain prokaryotes.
    B) Fixed nitrogen is often the limiting factor in plant growth.
    C) Nitrogen fixation is very expensive in terms of metabolic energy.
    D) Nitrogen fixers are sometimes symbiotic with legumes.

35. Sperm cells are formed in plants by _____.
    A) meiosis in pollen grains
    B) meiosis in anthers
    C) mitosis in male gametophyte
    D) mitosis in the micropyle

36. Which of the following types of plants are incapable of self-pollination?
    A) dioecious
    B) monoecious
    C) wind-pollinated
    D) insect-pollinated

37. Which one of the following hormones regulates cell division in plants?
    A) auxin (IAA)
    B) ethylene
    C) gibberellins
    D) cytokinins

38. Shoots that grow vertically toward the sun can be characterized as _____.
    A) positive for phototropism and negative for gravitropism
    B) neutral for phototropism and positive for gravitropism
    C) negative for phototropism and positive for gravitropism
    D) positive for phototropism and neutral for gravitropism

39. Connective tissues typically have _____.
A) little space between the membranes of adjacent cells
B) the ability to transmit electrochemical impulses
C) the ability to shorten upon stimulation
D) relatively few cells and a large amount of extracellular matrix

40. The metabolic breakdown of specialized brown fat deposits in certain animals is substantially increased during _____.
A) acclimatization
B) torpor
C) nonshivering thermogenesis
D) shivering thermogenesis

41. A zoologist analyzes the jawbones of an extinct mammal and concludes that it was an herbivore. The zoologist most likely came to this conclusion based upon the _____.
A) position of muscle attachment sites
B) shape of the teeth
C) size of the mouth opening
D) angle of the teeth in the mouth

42. An oil-water mixture works as an insecticidal spray against mosquitoes and other insects because it _____.
A) blocks the openings into the tracheal system
B) interferes with gas exchange across the capillaries
C) clogs their bronchi
D) prevents gases from leaving the atmosphere

43. Naturally acquired passive immunity can result from the _____.
A) injection of vaccine
B) ingestion of interferon
C) placental transfer of antibodies
D) absorption of pathogens through mucous membranes

44. Compared to wetland mammals, water conservation in mammals of arid regions is enhanced by having more _____.
A) juxtamedullary nephrons
B) urinary bladders
C) ureters
D) podocytes

45. Tadpoles must undergo a major metamorphosis to become frogs. This change includes reabsorption of the tail, growth of limbs, calcification of the skeleton, increase in rhodopsin in the eye, development of lungs, change in hemoglobin structure, and reformation of the gut from the long gut of an herbivore to the short gut of a carnivore. Amazingly, all of these changes are induced by thyroxine. What is the most likely explanation for such a wide array of effects of thyroxine?
    A) There are many different forms of thyroxine, each specific to a different tissue.
    B) Different tissues have thyroxine receptors that activate different signal transduction pathways.
    C) Some tissues have membrane receptors for thyroxine, while other tissues have thyroxine receptors within the nucleus.
    D) Different releasing hormones release thyroxine to different tissues.

46. You decide to study two species of birds, both of which form monogamous pairs (one male and one female). In species 1, you find that the eggs in a pair's nest are in fact almost always the offspring of that pair. In species 2, you are surprised to find that many of the eggs in a nest were actually fathered by males of neighboring pairs. Apparently, mating outside of monogamous pairings is widespread in species 2. What would you expect to observe if you examined the reproductive tracts of the female birds in the species?
    A) Females of species 2 would have sperm from multiple males in their reproductive tracts.
    B) Females of species 1 would have sperm from multiple males in their reproductive tracts, but would only use their partners' sperm to fertilize eggs.
    C) Ovaries of species 1 are larger than those of species 2.
    D) Females of species 1 would produce more oocytes.

47. In some rare salamander species, all individuals are females. Reproduction relies on those females having access to sperm from males of another species. However, the resulting embryos receive no genetic contribution from the males. Why do you think sperm are necessary for reproduction?
    A) The sperm allow morphogenesis to proceed.
    B) Sperm trigger egg activation.
    C) Cell differentiation is initiated by the sperm.
    D) Sperm are necessary to produce a diploid zygote.

48. What would probably happen if a long neuron had one continuous myelin sheath down the length of the axon with no nodes of Ranvier?
    A) The action potential would be propagated nearly instantaneously to the synapse.
    B) There could be no action potential generated at the axon hillock.
    C) The signal would fade because it is not renewed by the opening of more sodium channels.
    D) Only potassium could move across the membrane, but not sodium.

49. After suffering a stroke, a patient can see objects anywhere in front of him but pays attention only to objects in his right field of vision. When asked to describe these objects, he has difficulty judging their size and distance. What part of the brain was likely damaged by the stroke?
    A) the left frontal lobe
    B) the right frontal lobe
    C) the right parietal lobe
    D) the corpus callosum

50. Although some sharks close their eyes just before they bite, their bites are on target. Researchers have noted that sharks often misdirect their bites at metal objects and that they can find batteries buried under sand. This evidence suggests that sharks keep track of their prey during the split second before they bite in the same way that
    A) a rattlesnake finds a mouse in its burrow.
    B) an insect avoids being stepped on.
    C) a star-nosed mole locates its prey in tunnels.
    D) a platypus locates its prey in a muddy river.